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(71) Applicant: **TEXAS INSTRUMENTS INCORPORATED**
Dallas, Texas 75243 (US)

(72) Inventor: **Levine, Jules D.**
Dallas, TX 75248 (US)

(74) Representative: **Holt, Michael et al**
Texas Instruments Limited,
Kempton Point,
68 Staines Road West
Sunbury-on-Thames, Middlesex TW16 7AX (GB)

(54) Power management for a display device

(57) A field emission display electronics system includes a power reduction apparatus 40 in accordance with the present invention. The system includes a matrix-addressable emitter plate 14 and a voltage-switched trichromatic anode plate 10. In a reduced power consumption mode, the display is switched from a color mode to a monochrome mode, and power reduction apparatus 40 performs three functions, each of which contributes to power reduction of the display device. The first function disables the switched application of high voltage sequentially to the three combs of anode stripes 12_R, 12_G and 12_B, substituting the constant application of high voltage to all of the anode stripes 12, thus reducing the anode switching power to zero. The second function supplies a clock signal to column drivers 18 and row address counter/decoder 20 which is one-third the frequency of the clock signal used during color operation, thus reducing by two-thirds the capacitative power drop in row driver circuits 22, column driver circuits 18 and the emitter panel 14 over a color display. The third function performed by power reduction apparatus 40 is to provide display inversion. Data analyzer 60 senses the data being passed from the host to video controller 16, and determines whether the display data provided by video controller 16 to column drivers 18 should be altered so as to provide an inverted display. Three alternative schemata for controlling entry into the reduced power consumption mode are disclosed.

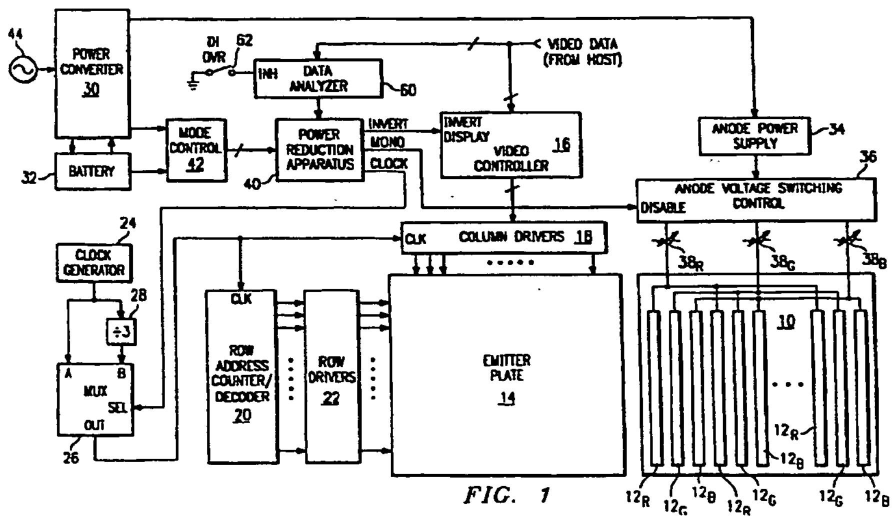

FIG. 1

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Description

Technical Field of the Invention

The present invention relates generally to portable field emission flat panel color display devices and, more particularly, to a structure and method for selectively enabling operation of such devices at reduced power consumption in order to extend the time which the portable display device may operate on battery power.

Background of the Invention

The advent of portable computers has created intense demand for display devices which are lightweight, compact and power efficient. Since the space and weight limitations on the display function of these devices preclude the use of a conventional cathode ray tube (CRT), there has been significant interest in efforts to provide satisfactory flat panel displays having comparable or even superior display characteristics, e.g., brightness, resolution, versatility in display, power consumption, etc. These efforts, while producing flat panel displays that are useful for some applications, have not produced a display that can compare to a conventional CRT.

Currently, liquid crystal displays are used almost universally for laptop and notebook computers. In comparison to a CRT, these displays provide poor contrast, only a limited range of viewing angles is possible, and, in color versions, they consume power at rates which are incompatible with extended battery operation. In addition, color screens tend to be far more costly than CRT's of equal screen size.

As a result of the drawbacks of liquid crystal display technology, field emission display technology has been receiving increasing attention by industry. Flat panel displays utilizing such technology employs a matrix-addressable array of pointed, thin-film, cold field emission cathodes in combination with an anode comprising a phosphor-luminescent screen. The phenomenon of field emission was discovered in the 1950's, and extensive research by many individuals, such as Charles A. Spindt of SRI International, has improved the technology to the extent that its prospects for use in the manufacture of inexpensive, low-power, high-resolution, high-contrast, full-color flat displays appear to be promising.

A flat panel display arrangement is disclosed in U.S. Patent No. 4,857,799, "Matrix-Addressed Flat Panel Display," issued Aug. 15, 1989, to Charles A. Spindt et al. This arrangement includes a matrix array of individually addressable light generating means of the cathodoluminescent type having cathodes combined with luminescing means of the CRT type which reacts to electron bombardment by emitting visible light. Each cathode is itself an array of thin film field emission cathodes on an emitter plate, and the luminescing means is provided as a phosphor coating on a transparent face plate which is closely spaced to the cathodes.

The emitter plate disclosed in the Spindt et al. patent includes a large number of vertical conductive stripes which are individually addressable. Each cathode includes a multiplicity of spaced-apart electron emitting tips which project upwardly from the vertical stripes on the emitter plate toward the face plate. An electrically conductive gate electrode arrangement is positioned adjacent to the tips to generate and control the electron emission. The gate electrode arrangement comprises a large number of individually addressable, horizontal stripes which are orthogonal to the cathode stripes, and which include apertures through which emitted electrons may pass. The gate electrode stripes are common to a full row of pixels extending across the top surface of the emitter structure, electrically isolated from the arrangement of cathode stripes. The anode is a thin film of an electrically conductive transparent material, such as indium tin oxide, which covers the interior surface of the face plate.

The matrix array of cathodes is activated by addressing the orthogonally related cathodes and gates in a generally conventional matrix-addressing scheme. The appropriate cathodes of the display along a selected stripe, such as along one column, are energized while the remaining cathodes are not energized. Gates of a selected stripe orthogonal to the selected cathode stripe are also energized while the remaining gates are not energized, with the result that the cathodes and gates of a pixel at the intersection of the selected horizontal and vertical stripes will be simultaneously energized, emitting electrons so as to provide the desired pixel display.

The Spindt et al. patent teaches that it is preferable that an entire row of pixels be simultaneously energized, rather than energization of individual pixels. According to this scheme, sequential lines are energized to provide a display frame, as opposed to sequential energization of individual pixels in a raster scan manner. This extends the duty cycle for each panel in order to provide enhanced brightness.

Other advances in field emission display technology are disclosed in U.S. Patent No. 4,940,916, "Electron Source with Micropoint Emissive Cathodes and Display Means by Cathodoluminescence Excited by Field Emission Using Said Source," issued 10 July 1990 to Michel Borel et at.; U.S. Patent No. 5,194,780, "Electron Source with Microtip Emissive Cathodes," issued 16 March 1993 to Robert Meyer; and U.S. Patent No. 5,225,820, "Microtip Trichromatic Fluorescent Screen," issued 6 July 1993, to Jean-Frédéric Clerc. These patents are incorporated by reference into the present application.

The Clerc ('820) patent discloses a trichromatic field emission flat panel display having a first substrate comprising the cathode and gate electrodes, and having a second substrate facing the first, including regularly spaced, parallel conductive stripes comprising the anode electrode. These stripes are alternately covered by a first material luminescing in the red, a second material luminescing in the green, and a third material luminescing in the blue, the conductive stripes covered by

the same luminescent material being electrically interconnected.

The Clerc patent discloses a process for addressing a trichromatic field emission flat panel display. The process consists of successively raising each set of interconnected anode stripes periodically to a first potential which is sufficient to attract the electrons emitted by the microtips of the cathode conductors corresponding to the pixels which are to be illuminated or "switched on" in the color of the selected anode stripes. Those anode stripes which are not being selected are set to a potential such that the electrons emitted by the microtips are repelled or have an energy level below the threshold cathodoluminescence energy level of the luminescent materials covering those unselected anodes.

Combining the line-at-a-time matrix address teachings of the Spindt et al. ('799) patent and the switched anode approach of the Clerc ('820) patent, it is seen that the process of producing each display frame using a typical field emission flat panel color display includes applying an accelerating potential to the red anode stripes while sequentially addressing the row lines (gate electrodes) with the corresponding red video data for that frame applied to the column lines (cathode electrodes), switching the accelerating potential to the green anode stripes while sequentially addressing the rows lines for a second time with the corresponding green video data for that flame applied to the column lines, and switching the accelerating potential to the blue anode stripes while sequentially addressing the row lines for a third time with the corresponding blue video data for that frame applied to the column lines. This process is repeated for each display frame.

The field emission flat panel color display of the type described above consumes significantly less energy than a comparable color liquid crystal display device. As an example, it is expected that power usage by a 10" diagonal VGA field emission display is on the order of two watts, while an equivalent color liquid crystal display is projected to use about six watts. Since the display screen tends to be the dominant energy consumer within a portable computer system, the use of a field emission device as the display allows extended battery operation life over a liquid crystal device. Alternatively, the use of a field emission device as the display permits the use of a smaller, lighter weight battery than is required by a liquid crystal display device for the same operating life. Even so, it is not seen where the present technology will provide the capability of operating a color notebook computer from a single battery pack for the duration of a transcontinental or intercontinental flight, often used as the standard of quality for such a system. Therefore, it is deemed desirable to be able to further reduce the power consumed by a field emission device display in order to extend the time which the portable computer may operate on battery power and/or to reduce the size requirements for the battery.

Summary of the Invention

In accordance with the principles of the present invention, there is disclosed display apparatus. The apparatus comprises means for switching the apparatus between a normal power consumption mode and a reduced power consumption mode, and means for altering display characteristics when the apparatus is in the reduced power consumption mode, the altering means providing a monochrome display.

Further in accordance with the principles of the present invention, there is disclosed herein a field emission color display apparatus wherein the display includes an information portion comprising alphanumeric characters and graphic symbols and a background portion. The apparatus comprises means for switching the apparatus between a normal power consumption mode and a reduced power consumption mode, and means for altering display characteristics when the apparatus is in the reduced power consumption mode, the altering means ensuring that the display of the information portion is relatively brighter than the display of the background portion.

In accordance with a preferred embodiment of the present invention, the field emission color display apparatus includes an emitter plate comprising a plurality of column conductors intersecting a plurality of row conductors, and electron emitters at the intersection of each of the row and column conductors; and an anode plate adjacent the emitter plate, the anode plate comprising conductive stripes which are alternately covered by materials of color luminescence, the conductive stripes covered by the same luminescent material being electrically interconnected to form comb-like structures corresponding to each color.

The preferred embodiment further includes column circuitry including drivers for applying display data signals to the plurality of column conductors, row circuitry including drivers for sequentially applying a potential to the plurality of row conductors, and means for generating clocking signals to the column circuitry and the row circuitry for providing emission selectively from the electron emitters, the altering means reducing the frequency of the clocking signals when the apparatus is in the reduced power consumption mode.

The preferred embodiment still further includes means for applying switched potentials successively to the combs of electrically interconnected anode stripes when the apparatus is in the normal power consumption mode, the altering means causing constant potentials to be applied to each of the combs of anode stripes when the apparatus is in the reduced power consumption mode.

In an embodiment of the present invention, there are included means for coupling the apparatus to a first power source, the apparatus being capable of operation from the first power source for a limited time; and means for coupling the apparatus to a second power source, the first power source providing power to the apparatus

when the apparatus is remote from the second power source. The reduced power consumption mode may be initiated by determining that the voltage level of the first power source has dropped to a predetermined threshold. Alternatively, the reduced power consumption mode may be initiated by detecting the absence of potential from the second power source.

According to a second embodiment of the invention there is provided a method of displaying information on display apparatus, comprising switching the apparatus between a normal power consumption mode and a reduced power consumption mode, and altering the display characteristics of the apparatus when the apparatus is in the reduce power consumption mode.

Brief Description of the Drawing

The foregoing features of the present invention may be more fully understood from the following detailed description, read in conjunction with the accompanying drawings, wherein:

FIG. 1 is a block diagram of a field emission display electronics system in accordance with the present invention; and
FIGS. 2A, 2B and 2C are block diagram illustrations of three alternative schemata for controlling the power reduction apparatus of the system of FIG. 1.

Description of the Preferred Embodiment

Referring initially to FIG. 1, there is shown a block diagram of a field emission display electronics system which includes a power reduction apparatus 40 in accordance with the present invention. The system includes a matrix-addressable emitter plate 14, which may be of the type described in the Spindt et al. ('799) patent, and a trichromatic anode plate 10, which may be of the type described in the Clerc ('820) patent. Anode plate 10 includes a multiplicity of regularly spaced, parallel conductive stripes 12_R, 12_G and 12_B, referred to collectively as stripes 12, comprising the anode electrode. These stripes 12 are alternately covered by a first material luminescing in the red, a second material luminescing in the green, and a third material luminescing in the blue, the conductive stripes covered by the same luminescent material being electrically interconnected so as to form a comb-like structure. As described earlier, plates 10 and 14 are positioned in facing relationship such that the electrons emitted from emitter plate 14 are drawn toward the high potential anode stripes 12_R, 12_G and 12_B of anode plate 10.

Anode power supply 34 is responsive to power converter 30 for providing a high voltage to anode voltage switching control 36, typically on the order of 300 to 800 volts. Anode voltage switching control 36 provides voltages sequentially to the three combs of anode stripes 12_R, 12_G and 12_B, each of these voltages being set to a level in accordance with the brightness characteristics of the corresponding luminescent material.

The column lines (cathode electrodes) (not shown) of matrix-addressable emitter plate 14 are individually coupled to column drivers 18. Drivers 18 receive video data from the host device, which has been formatted by video controller 16 into separate red, green and blue display frames from an original mixed signal. In this example, video controller 16 may process the video data according to the VGA standard, and may typically output 640 parallel lines of data to 640 column drivers 18, to thereby provide one color component of a single row of the display. The data from video controller 16 are latched into column drivers 18 upon each occurrence of a clock signal received at the CLK input terminal.

The row lines (gate electrodes) (not shown) of matrix-addressable emitter plate 14 are individually coupled to row drivers 22. Drivers 22 receive enable signals from the row address counter/decoder 20. Device 20 includes a counter which is responsive to each occurrence of a clock signal received at the CLK input terminal, and a decoder which applies an enabling signal sequentially to each of the row drivers 22. In this example, the counter of device 20 may counter to 480, the decoder portion of device 20 applying enabling signals sequentially to each of 480 row drivers 22.

Clock generator 24 provides the clock input signals to column drivers 18 and row address counter/decoder 20 via its A input terminal through multiplexer 26 during color operation of the display device of the present invention. Each occurrence of the clock signal latches a row of video data signals into column drivers 18 and enables a single one of row drivers 22. Each display frame requires that each one of row drivers 22 be enabled for each of the three colors. Thus it is seen that, in the present example, 480 ' 3 = 1,440 clock pulses are required for a complete three-color display frame.

In a preferred arrangement, video controller 16, column drivers 18, row address counter/decoder 20, row drivers 22 and clock generator 24 may all be fabricated on the substrate comprising emitter plate 14.

The power system of the display device of the present invention includes a power converter 30 which is responsive either to a source of ac power 44 or to a battery 32 for providing the system power requirements, including the power required by anode power supply 34. In a preferred arrangement, power converter provides charging current to battery 32 when power converter is coupled to ac source 44. When power converter 30 is uncoupled from source 44, i.e., when the display device is being used as a portable device, battery 32 is required to provide all system power requirements.

In accordance with the present invention, apparatus is included within the above-described display device, such apparatus enabling reduction of the power consumption of the display device, thereby extending the operating life of the device while it is drawing power from battery 32 or reducing the size and weight of battery 32 for a predetermined operating life. The power reduction

apparatus is shown as element 40 and will be described by the functions it performs and by its relationships to the other elements of the display device, rather than by any specific parts embodiment. It is deemed that one skilled in the art will be able, from a functional description thereof, to fabricate any number of arrangements within power reduction apparatus 40 for implementing those functions.

In a reduced power consumption mode, the display is switched from a color mode to a monochrome mode, and power reduction apparatus 40 performs three functions, each of which contributes to power reduction of the display device.

The first function performed by power reduction apparatus 40 derives from the change from the color mode to the monochrome mode. A signal styled "MONO" is generated by apparatus 40 to a DISABLE input terminal of anode voltage switching control 36. This signal provides the effect of disabling the switched application of high voltage sequentially to the three combs of anode stripes 12_R, 12_G and 12_B of anode plate 10, and substituting the constant application of high voltage to all of the anode stripes 12. With the anode voltage switching function disabled, the anode switching power is reduced to zero.

The display color can be adjusted to a hue pleasing to the viewer by use of voltage controls 38_R, 38_G and 38_B, referred to collectively as voltage controls 38. The depiction of voltage controls 38 as resistive is merely functional; in practice, one skilled in the art to which it pertains may alternatively implement voltage controls 38 in solid state hardware and/or via programming function.

The second function performed by power reduction apparatus 40 also derives from the display device change from the color mode to the monochrome mode. In the monochrome mode, the display no longer needs to sweep through all of the row drivers 22 three times per display frame, only one sweep being required for a single color. A signal styled "CLOCK" is generated by apparatus 40 to the select (SEL) input terminal of multiplexer 26, causing the signal at its B input terminal to be coupled to its output (OUT) terminal. A divide-by-three circuit 28, coupled between the output terminal of clock generator 24 and multiplexer 26 thus supplies a clock signal to column drivers 18 and row address counter/decoder 20 which is one-third the frequency of the clock signal used during color operation. Using this reduced-frequency clock signal, the row driver circuits 22, the column driver circuits 18 and the emitter panel 14 will consume one-third the capacitive power of a color display.

The third function performed by power reduction apparatus 40 is to provide display inversion, via a signal styled "INVERT" coupled to video controller 16. This function is frequently offered as a user-selectable switch in portable computers having liquid crystal displays, although there is no power savings benefit from inverting the display in such a device. Since a significant library of business-oriented software, e.g., Word, Excel, Windows applications, etc., defaults to dark text or graphics on a light background, the use of image inversion reduces beam power to a minimal value for such programs. As implemented herein, data analyzer 60 senses the data being passed from the host to video controller 16, recognizing that the dominant form of data comprises the background shade, and the less frequently occurring form of data represents the alphanumeric characters and graphic symbols of the display. From this information and recognizing that white text or graphics against a black background is the more power-efficient form of operation of a field emission display device, an output signal from data analyzer 60 to power reduction controller 40 determines whether the display data provided by video controller 16 to column drivers 18 should be altered so as to provide an inverted display. A display inversion override control, shown functionally as DI OVR switch 62, inhibits the automatic display inversion feature to prevent unwanted inversions of, for example, a highly-dynamic video display.

FIGS. 2A, 2B and 2C are block diagram illustrations of three alternative schemata for controlling the power reduction apparatus 40 of the system of FIG. 1. These schemata are intended to provide mere functional depictions of structure for switching operation of the display system between the normal mode and an energy conservation (or reduced power consumption) mode. FIGS. 2A through 2C illustrate three embodiments of the elements of the mode control circuitry 42 coupled to power reduction apparatus 40 of FIG. 1. It will be noted that where the reference numerals of two or more of the circuit elements of FIGS. 1 and 2A through 2C differ only in the hundreds place, such elements are similar or substantially identical. For example, power reduction apparatus 40 of FIG. 1 is similar to apparatus 140 of FIG. 2B, apparatus 240 of FIG. 2C and apparatus 340 of FIG. 2C.

Referring to FIG. 2A, power reduction apparatus 140 includes an ENABLE input which can be at a logic "1" level or a logic "0" (or reference ground) level. For the purposes of this illustration, apparatus 140 is enabled into the energy conservation (EC) mode in response to a logic "1" level, and into the normal power consumption mode in response to a logic "0" level. EC MODE switch 146, when actuated to its closed position, couples a logic "0" level to the input of logic inverter 148, whose output terminal is coupled to the ENABLE input terminal of power reduction apparatus 140. Thus, in the embodiment shown functionally in FIG. 2A, EC MODE switch 146 provides manual toggle control of the power consumption operating mode of the display system of the present invention.

Referring now to FIG. 2B, power reduction apparatus 240 includes an ENABLE input which, like apparatus 140 of FIG. 2A, enables apparatus 240 into the EC mode in response to a logic "1" level, and into the normal power consumption mode in response to a logic "0" level. This embodiment includes a threshold detector 250 coupled to battery 232 which provides a logic "0" level output signal when the voltage level of battery 232 drops below a predetermined threshold level. This signal is coupled

through logic NAND gate 252 and logic AND gate 256 to provide the EC mode enabling signal to power reduction apparatus 240. EC MODE switch 246, when actuated to its closed position, couples a ground level (logic "0") voltage to the second input of NAND gate 252, thereby also providing the ENABLE to apparatus 240. OVR switch 254, when actuated to its closed position, couples a ground level (logic "0") voltage to the second input of AND gate 256, thereby overriding the enabling effect of either threshold detector 250 or EC mode switch 246. Thus, in the embodiment shown functionally in FIG. 2B, threshold detector 250 provides automatic enabling of the EC mode when the display system battery voltage drops below a predetermined level, and EC MODE switch 246 provides manual enabling of the EC mode, while OVR switch 254 is capable of overriding either of the above enabling features, forcing the display system of the present invention into the normal power consumption operating mode.

Referring finally to FIG. 2C, power reduction apparatus 340 includes an ENABLE input which, like apparatus 140 of FIG. 2A, enables apparatus 340 into the EC mode in response to a logic "1" level, and into the normal power consumption mode in response to a logic "0" level. In this embodiment, power converter 330 provides a logic "1" level output signal NO AC to indicate that it is not coupled to a source of ac power. This signal is coupled through logic AND gate 356 to provide the EC mode enabling signal to power reduction apparatus 340. OVR switch 354, when actuated to its closed position, couples a ground level (logic "0") voltage to the second input of AND gate 356, thereby overriding the enabling effect of the NO AC output signal from power converter 330. Thus, in the embodiment shown functionally in FIG. 2C, power converter 330 provides automatic enabling of the EC mode when there is no source of ac power, while OVR switch 354 is capable of overriding this automatic feature, forcing the display system of the present invention into the normal power consumption operating mode.

Whereas conventional symbols for switches and logic elements are depicted in the figures and used in the descriptions of the accompanying text, it will be recognized by those of skill in the art to which it pertains that such representations are merely functional, and that an actual implementation of the apparatus of the present invention would likely include solid state devices in conjunction with computer software illustratively responding to the function keys of a computer keyboard for these purposes.

A field emission flat panel display device, as disclosed herein, including a power reduction apparatus which alters operating features of the display device to thereby reduce the amount of power consumed by the device, provides significant advantages over the display devices of the prior art. First, by operating the system in monochrome, rather than in a color mode, all of the anode stripes are held at a constant potential, and no anode switching takes place. Thus, the anode switching power is reduced to zero.

Second, since the operation in monochrome requires only a single sweep across the emitter plate for each display frame, as contrasted with three sweeps (red, green and blue) for each color display frame, the row and column driver circuits and the emitter panel will consume one-third the capacitive power of a color display of the type described herein.

Third, beam current energy (beam current multiplied by anode voltage) is minimized by the use of white text or graphics on a black background. Since a significant library of business-oriented software ordinarily displays dark text or graphics on a light background, the use of image inversion reduces beam power to a minimal value for such programs.

It is expected that the power consumption of a 10" diagonal VGA field emission display can be reduced from about two watts in the full color mode to about one-half watt in the energy conservation mode. Since a liquid crystal display device requires a back-lighted screen, there is no power savings benefit from switching from color to monochrome, nor is there any power savings benefit derived from text/background display image inversion, in such a device.

While the principles of the present invention have been demonstrated with particular regard to the structures and methods disclosed herein, it will be recognized that various departures may be undertaken in the practice of the invention. For example, while the disclosure describes a switched anode structure, it will be recognized that the present invention may be applied equally to a field emission display device using a tetrode arrangement for focusing the emitted electrons to the anode stripe of the desired color. Furthermore, while the disclosure describes a three-color display device, it is intended to include any color display generation scheme employing field emission. The scope of the invention is not intended to be limited to the particular structures and methods disclosed herein, but should instead be gauged by the breadth of the clams which follow.

Claims

1. Display apparatus comprising:

   switching means for switching said apparatus between a normal power consumption mode and a reduced power consumption mode; and

   altering means for altering display characteristics when said apparatus is in said reduced power consumption mode, said altering means providing an altered display.

2. The display of Claim 1, wherein the altered display is a monochrome display.

3. The display of Claim 1 or Claim 2, wherein the display includes an information portion comprising alphanumeric characters and graphic symbols and a background portion, and wherein:

   said altering means ensure that the display

of said information portion is relatively brighter than the display of said background portion.

4. The display of any preceding claim, further comprising:

an emitter plate comprising a plurality of column conductors intersecting a plurality of row conductors, and electron emitters at the intersection of each of said row and column conductors;

an anode plate adjacent said emitter plate, said anode plate comprising conductive stripes which are alternately covered by materials of color luminescence, said conductive stripes covered by the same luminescent material being electrically interconnected to form comb-like structures corresponding to each color;

5. The display of Claim 4, further comprising:

column circuitry including drivers for applying display data signals to said plurality of column conductors;

row circuitry including drivers for sequentially applying a potential to said plurality of row conductors; and

means for generating clocking signals to said column circuitry and said row circuitry for providing emission selectively from said electron emitters,

said altering means reducing the frequency of said clocking signals when said apparatus is in said reduced power consumption mode.

6. The display of Claim 4 or Claim 5, further comprising means for applying switched potentials successively to said combs of electrically interconnected anode stripes when said apparatus is in said normal power consumption mode, said altering means causing constant potentials to be applied to each of said combs of anode stripes when said apparatus is in said reduced power consumption mode.

7. The display of with Claim 6, further comprising means for adjusting the constant potentials applied to each of said combs of anode stripes when said apparatus is in said reduced power consumption mode to thereby adjust the hue of said monochrome display.

8. The display of any preceding claim, further comprising:

means for coupling said apparatus to a first power source, said apparatus being capable of operation from said first power source for a limited time.

9. The display of Claim 8, further including means for coupling said apparatus to a second power source, said first power source providing power to said apparatus when said apparatus is remote from said second power source.

10. The display of Claim 8 or Claim 9, wherein said switching means comprises means for determining when the voltage level of said first power source has dropped to a predetermined threshold.

11. The display of with Claim 9 or Claim 10, wherein said switching means comprises means for detecting the absence of potential from said second power source.

12. The display of any of Claims 9 to 11, wherein said second power source comprises an ac current source.

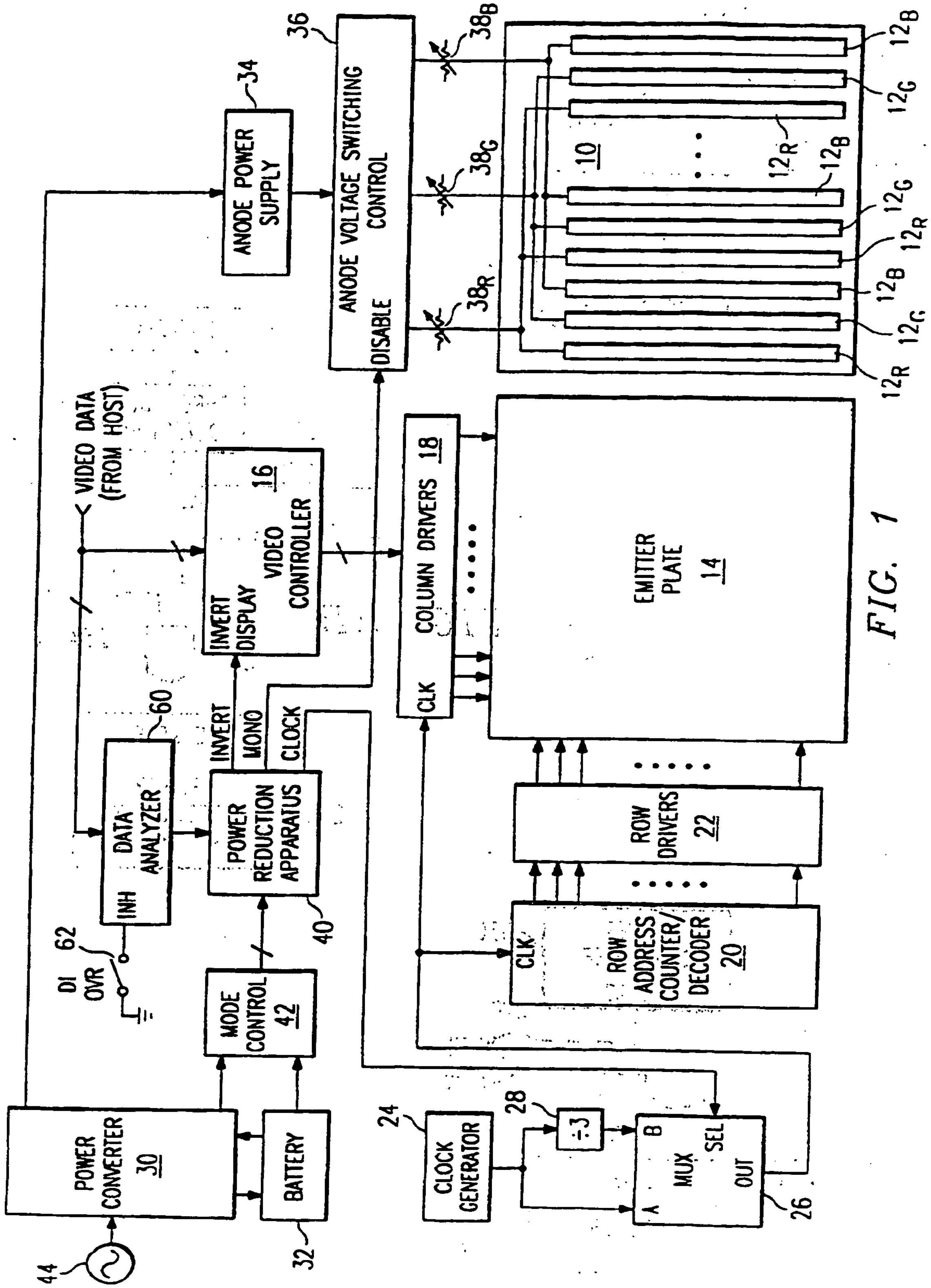
13. The display of any of Claims 8 to 11, wherein said first power source comprises a battery.

14. The display of any preceding claim wherein the display is in the form of a field emission colour display.

15. A method of displaying information on display apparatus, comprising;

switching the apparatus between a normal power consumption mode and a reduced power consumption mode; and

altering the display characteristics of the apparatus when the apparatus is in the reduce power consumption mode.


ANODE POWER SUPPLY
34
36
ANODE VOLTAGE SWITCHING CONTROL
DISABLE
38_B
38_G
38_R
10
12_B
12_G
12_R
VIDEO DATA (FROM HOST)
VIDEO CONTROLLER 16
INVERT DISPLAY
COLUMN DRIVERS 18
CLK
EMITTER PLATE 14
DATA ANALYZER
INH
60
INVERT
MONO
CLOCK
POWER REDUCTION APPARATUS
40
ROW DRIVERS 22
DI OVR
62
MODE CONTROL 42
ROW ADDRESS COUNTER/DECODER 20
POWER CONVERTER 30
BATTERY
32
44
CLOCK GENERATOR
24
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÷3
MUX
A
B
SEL
OUT
26

FIG. 1

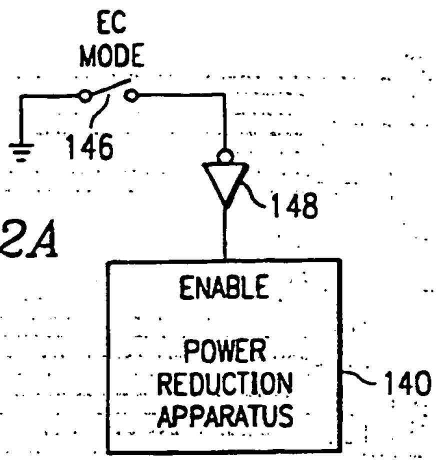

FIG. 2A

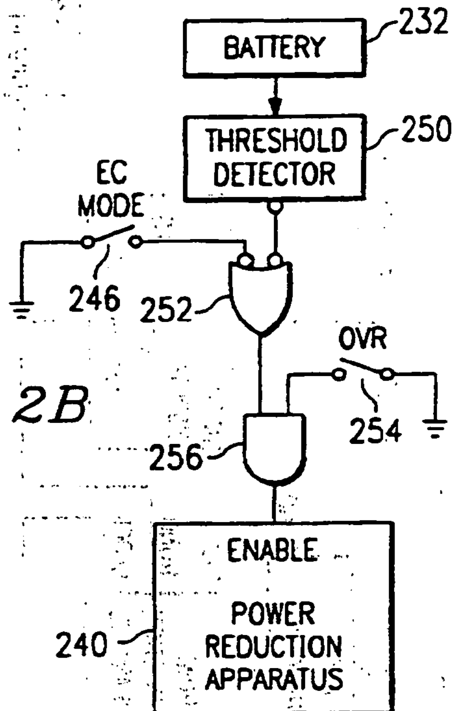

FIG. 2B

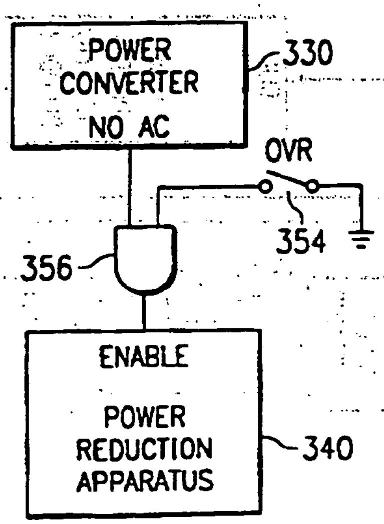

FIG. 2C

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 4252

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 443 083 (KABUSHIKI KAISHA TOSHIBA) 28 August 1991 * abstract; figures 1-3 * * column 2, line 42 - column 3, line 57 * ---	1,8-13, 15	G09G3/22
A,D	EP-A-0 349 426 (COMMISSARIAT A L'ENERGIE ATOMIQUE) 3 January 1990 * abstract; figures 1-3 * -----	4-6	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
G09G
G06F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 December 1995	Van Roost, L

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)